

WHAT IS CLAIMED IS:

1. An apparatus for cleaning residual material from an article comprising:

a) a source of a cleaning agent;

b) at least one pair of opposing spray nozzle assemblies directed to spray an article interposed between the opposing spray nozzle assemblies, a first of the opposing spray nozzle assemblies comprising a first nozzle for spraying the cleaning agent in a first pattern and a second nozzle for spraying the cleaning agent in a second pattern, and a second of the opposing spray nozzle assemblies comprising a first nozzle for spraying the cleaning agent in a first pattern;

c) a supply conduit from the source of the cleaning agent to each of the first and second nozzles;

d) a power source electrically connected to the second nozzle; and

e) a transport apparatus to transport one of the opposing nozzle assemblies and the article with respect to each other;

f) wherein, in operation, in a first pass the first nozzle of

19 at least the first nozzle assembly is operable to spray the
20 article with a spray of the cleaning agent as the first nozzle
21 assembly and article are transported with respect to each
22 other to chemically and mechanically remove residual material
23 from the article and in a second pass the second nozzle of the
24 first nozzle assembly is operable to spray the article with a
25 cleaning agent as a voltage is applied between the second
26 nozzle of the first nozzle assembly and the article and as the
27 first nozzle assembly and article are transported with respect
28 to each other to chemically and electrochemically remove the
29 remaining residual material from the article.

1 2. The apparatus of claim 1 wherein, in operation, the first
2 nozzle of the second nozzle assembly is operable in
3 conjunction with the first nozzle of the first nozzle assembly
4 during the first pass to chemically and mechanically remove
5 residual material from the article.

1 3. The apparatus of claim 1, wherein, in operation, the first
2 nozzle of the second assembly is operable in conjunction with
3 the second nozzle of the first nozzle assembly during the
4 second pass to chemically and mechanically remove residual
5 material from the article.

1 4. The apparatus of claim 1 wherein the first and second
2 nozzle assemblies further comprise a rinsing nozzle and
3 wherein, in operation, in a third pass the rinsing nozzles of
4 the first and second nozzle assemblies are operable to spray
5 a rinsing fluid on the article as the nozzle assemblies and
6 article are transported with respect to each other to rinse
7 the cleaning agent from the article.

1 5. The apparatus of claim 1 wherein the supply conduit for at
2 least the second nozzle is insulating and of sufficient length
3 so as to create a resistance that is at least an order of
4 magnitude greater than a resistance between the second nozzle
5 and the article.

1 6. The apparatus of claim 1 wherein the cleaning agent is
2 TMAH.

1 7. The apparatus of claim 6 wherein the concentration of the
2 TMAH in the spray in the first and second passes is in the
3 range of 0.2 to 2 weight percent, preferably 0.4 to 0.5 weight
4 percent..

1 8. The apparatus of claim 1 wherein the second nozzle
2 comprises a plurality of holes through which the cleaning
3 agent is sprayed, the holes having a diameter of 0.030 inches
4 with a center to center pitch spacing of 0.066 for a
5 pitch/hole diameter ratio of 2.2.

1 9. The apparatus of claim 6 wherein the concentration of the
2 TMAH in the spray in the first and second passes is the same.

1 10. The apparatus of claim 1 wherein the article is a metallic
2 screening mask.

1 11. The apparatus of claim 1 wherein the residual material is
2 a metal-containing paste.

1 12. An apparatus for cleaning residual material from an
2 article comprising:

3 a) a source of a cleaning agent;

4 b) at least one pair of opposing spray nozzle assemblies
5 directed to spray an article interposed between the opposing

6 spray nozzle assemblies with each of the opposing spray nozzle
7 assemblies comprising a first nozzle for spraying the cleaning
8 agent in a first pattern and a second nozzle for spraying the
9 cleaning agent in a second pattern;

10 c) a supply conduit from the source of the cleaning agent to
11 each of the first and second nozzles;

12 d) a power source electrically connected to the second
13 nozzles; and

14 e) a transport apparatus to transport one of the opposing
15 nozzle assemblies and the article with respect to each other;

16 f) wherein, in operation, in a first pass the first nozzle of
17 each of the nozzle assemblies is operable to spray the article
18 with a spray of the cleaning agent as the nozzle assemblies
19 and article are transported with respect to each other to
20 chemically and mechanically remove residual material from the
21 article and in a second pass the second nozzles of each of the
22 nozzle assemblies is operable to spray the article with a
23 cleaning agent as a voltage is applied between the second
24 nozzles of each of the nozzle assemblies and the article and
25 as the nozzle assemblies and article are transported with
26 respect to each other to chemically and electrochemically
27 remove the remaining residual material from the article.

1 13. The apparatus of claim 12 wherein the first and second
2 nozzle assemblies further comprise a rinsing nozzle and
3 wherein, in operation, in a third pass the rinsing nozzles of
4 the first and second nozzle assemblies are operable to spray
5 a rinsing fluid on the article as the nozzle assemblies and
6 article are transported with respect to each other to rinse
7 the cleaning agent from the article.

1 14. The apparatus of claim 13 wherein the supply conduit for
2 at least the second nozzles is insulating and of sufficient
3 length so as to create a resistance that is at least an order
4 of magnitude greater than a resistance between the second
5 nozzles and the article.

1 15. The apparatus of claim 12 wherein the cleaning agent is
2 TMAH.

1 16. The apparatus of claim 15 wherein the concentration of
2 the TMAH in the spray in the first and second passes is in the
3 range of 0.2 to 2 weight percent, preferably 0.4 to 0.5 weight
4 percent.

1 17. The apparatus of claim 12 wherein the second nozzles
2 comprise a plurality of holes through which the cleaning agent
3 is sprayed, the holes having a diameter of 0.030 inches with
4 a center to center pitch spacing of 0.066 for a pitch/hole
5 diameter ratio of 2.2.

1 18. The apparatus of claim 15 wherein the concentration of
2 the TMAH in the spray in the first and second passes is the
3 same.

1 19. The apparatus of claim 12 wherein the article is a
2 metallic screening mask.

1 20. The apparatus of claim 12 wherein the residual material
2 is a metal-containing paste.